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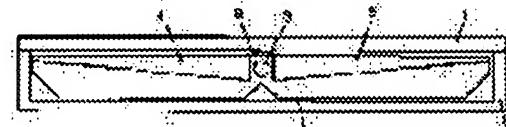
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## (54) SURFACE LIGHT SOURCE DEVICE AND LIQUID CRYSTAL DISPLAY DEVICE

### (57) Abstract:

**PROBLEM TO BE SOLVED:** To make a surface light source device thinner, lighter in weight and to reduce a cost with respect to the large screen display of high luminance by providing one pair of light transmission plates, the light diffusing means suspended on the surface of the same flat surface side in between the light transmission plates and a light reflecting means at a surface side opposite to the same flat surface side of the light transmission plates.



**SOLUTION:** This light source unit is composed of a piece of a long light source 3, one pair of light transmission plates 4, 5 diffusing radiant lights of the left and right directions from the light source 3 on all surfaces of the display area of a display panel 1, a diffusion member 6 transmittingly diffusing the radiant lights from the light source 3 and a reflection plate reflection lights of a direction opposite to the panel 1. Incident lights on the light transmission plates 4, 5 are diffracted by V grooves being at a side opposite to a light-emitting surface while being totally reflected to be emitted from the light-emitting surface. However, lights transmitting the diffusion member 6 are emitted in a panel 1 direction, reflected lights pass the gap between the light source 3 and the plates 4, 5 to be guided to the reflection plate 7. Optical paths of lights radiated to the lower direction from the lights source 3 are changed with slopes of chevron projecting part being on the reflection plate 7 and the lights are reflected by the inclinations of both end parts of the plate 7 to be emitted in the panel 1 direction.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the surface light source equipment used for back lights, such as an illumination display and a liquid crystal display.

[0002]

[Description of the Prior Art] As surface light source equipment conventionally used for the back light of a liquid crystal display etc., the edge mold which leads light to a viewing area and illuminates it with the direct female mold which allots the light source in the viewing area by the rear-face side of a liquid crystal panel, and is illuminated by the direct solar radiation from the light source, and the light guide plate which allots the light source to the outside of the viewing area by the rear-face side of a liquid crystal panel, and consists of transparency acrylic resin etc. is common.

[0003] In such surface light source equipment, since there is a limit in the area which can be illuminated by the singular light source, the technique using two or more light sources is proposed to the latest enlargement of the display screen and the latest raise in brightness.

[0004] Although there were some which carried out the parallel array of two or more light sources as shown in JP,7-141908,A with spacing as an example of direct female mold, the right above section of the light source became high brightness, it was required to be easy to generate brightness unevenness in the shape of stripes, and to enlarge distance of a panel and the light source, and there was a problem to which equipment becomes thick.

[0005] Moreover, although the light source is arranged as an example of an edge mold around a light guide plate as shown in JP,8-36178,A or JP,9-90135,A or some which arranged two or more light sources were in the end face of a light guide plate, there was a problem to which the non-display field around the display screen becomes large, and the board thickness of a light guide plate becomes large, and the whole equipment becomes heavy.

[0006] Moreover, although the synchrotron orbital radiation from the light source was reflected by the lamp reflector led to the incidence end face of a light guide plate, most was interrupted by the light source and the use effectiveness of the synchrotron orbital radiation from the light source had it. [ low ]

[0007] Moreover, direct female mold and an edge mold are combined, the light source is allotted directly under a panel and the technique constituted so that you might make it spread with a light guide plate is shown in JP,9-61821,A.

[0008] The crevice was established in the central subordinate side of a light guide plate, as shown in drawing 7, it is what has arranged the light source to this crevice, and the dot pattern for optical diffusion was printed by the inferior surface of tongue and crevice of a light guide plate, and this technique is \*\*.

[0009]

[Problem(s) to be Solved by the Invention] However, there were various problems in illuminating a big screen by high brightness with the above techniques.

[0010] Location fluctuation tended to take place for vibration or deflection, when the location of the light source changed [ the light source and the plane-of-incidence configuration of the light guide plate which counters ] in the case of the curved surface or the polygon side, the luminance distribution from a light guide plate changed, and the light source which is a super-thin long configuration caused brightness unevenness.

[0011] Moreover, although arranging two or more light sources to a crevice, or forming two or more crevices in it under a light guide plate, and arranging the light source to each is also proposed in order to plurality-ize the light source for example, since it corresponds to the display of a raise in brightness, or big-screen-izing When the thickness of a light guide plate increased and it became heavy, when more than one were arranged, and two or more crevices were prepared, technical problems, like the handling nature at the time of assembly is [ that it is easy to generate the strain at the time of processing of shaping etc., and deflection and a crack ] bad occurred.

[0012] Moreover, when the crevice was formed in the central subordinate side of a light guide plate and the light source was held, the optical outgoing radiation side of a light guide plate distorted with the heat from the light source, and it had had a bad influence on the display image.

[0013] This invention aims at offering cheap surface light source equipment by the thin light weight also to the display of a big screen by high brightness.

[0014]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention has a gap in the straight pipe-like light source and the light source, and it is characterized by equipping an optical diffusion means [ by which phase opposite was carried out, the light guide plate of the pair which has one field which intersects perpendicularly with the light source and the field which counters in the same flat surface, and the light guide plate of a pair did, and suspension was carried out to the field by the side of the same flat surface ], same flat-surface [ of a light guide plate ], and opposite side side with a light reflex means.

[0015] The light guide plate of the pair which this invention has a gap in the straight pipe-like light source and the light source, and furthermore has one field which carries out phase opposite and intersects perpendicularly with the light source and the field which counters in the same flat surface, With the light source, in the location which is in the gap section of the light guide plate of a pair, and counters by the same flat-surface side of a light guide plate an optical diffusion means Are a same flat-surface and opposite side side, equip the light source and the location which counters with a light reflex means, and on two ellipse curved surfaces which have a focus in the point which the light source of an optical diffusion means and the field which counters have in the minimum distance from the light source central point on the field of the central point of the light source, the light source, and the light guide plate with which it counters It is characterized by the light source of a light reflex means and the field which counters being the configurations projected to the light source side in the shortest location with the light source.

[0016] Moreover, the light guide plate of the pair which this invention which attains the above-mentioned purpose has a gap in the straight pipe-like light source and the light source, and has one field which carries out phase opposite and intersects perpendicularly with the light source and the field which counters in the same flat surface, In two or more light source modules which consist of an optical diffusion means by which the light guide plate of a pair did and suspension was carried out to the field by the side of the same flat surface, are parallel to the shaft orientations of the light source. While arranging the field of the light guide plate in the same flat surface of a light source module so that it may become the same flat surface, it is characterized by having a light reflex means throughout an opposite side side the same flat-surface side of a light guide plate.

[0017] Moreover, the light guide plate of the pair which this invention has a gap in the straight pipe-like light source and the light source, and has one field which carries out phase opposite and intersects perpendicularly with the light source and the field which counters in the same flat surface, While it is parallel to the shaft orientations of the light source, and carrying out array support of two or more illumination modules which consist of an optical diffusion means by which the light guide plate of a pair did and suspension was carried out to the field by the side of the same flat surface so that the field by the side of the same flat surface of each light guide plate may turn into the same flat surface The same flat-surface side of an illumination module is equipped with a liquid crystal panel, a same flat-surface [ of an illumination module ] and opposite side side is equipped with a reflective means, and it is characterized by making the array pitch of an illumination module into the integral multiple of the pixel pitch of a liquid crystal panel.

[0018] Furthermore, it is characterized by making the connecting location of an adjoining optical unit agree in the non-pixel location of a liquid crystal panel.

[0019] By carrying out the modularization of the light guide plate of a pair to the light source, and arranging two or more these by the above-mentioned configuration, this invention can realize illumination of a big screen and can offer lightweight surface light source equipment with a thin shape.

[0020] in order [ moreover, ] to lead a part of light of the right above direction to a reflecting plate and to carry out incidence to a light guide plate again through the gap of a light guide plate and a reflecting plate among the synchrotron orbital radiation from the light source, without being interrupted by the light source with an optical diffusion means -- use effectiveness -- remarkable -- rising -- high -- brightness illumination is possible.

[0021] Moreover, two or more two or more light source modules can be arranged in parallel, and the liquid crystal display of the big screen which does not spoil visibility can be offered by making the connecting location into the non-pixel location of a liquid crystal panel.

[0022] [Embodiment of the Invention] Hereafter, the 1st example of this invention is explained using drawing.

[0023] Fig. 1 and Fig. 2 show the structure of this invention, and Fig. 3 shows the detail structure of a light source unit.

[0024] The display panel with which, as for 1, the transparency image was printed by the film resin of transparency etc., and 2 are the housing objects which support a display panel 1, and the light source unit is held in the interior.

[0025] The light source unit consists of the light source 3 of one long picture, a light guide plate 4-5 of the pair which diffuses the synchrotron orbital radiation of the longitudinal direction from the light source 3 all over the viewing area of a display panel 1, a diffusion member 6 that carries out transparency diffusion of the synchrotron orbital radiation above [ from the light source 3 ], and a display panel 1 and the reflecting plate 7 made to reflect the light of an opposite direction.

[0026] The light sources 3 have the shape of a straight pipe, such as a cold cathode fluorescent lamp, and both ends are supported by the housing object 2 free [ attachment and detachment ], and they are turned on by the drive circuit which is not illustrated.

[0027] The light guide plate 4-5 of a pair is the plate of the rectangle which consists of transparency material, such as acrylic resin, with a gap, plane-of-incidence 4a and 5a of light counter, and is arranged at the both sides of the light source 3, and it is supported by the housing object 2 so that outgoing radiation side 4b and 5b which intersects perpendicularly with plane-of-incidence 4a and 5a may become the same flat surface.

[0028] Outgoing radiation side 4b and 5b of a light guide plate, and field 4c and 5c of the opposite side incline so that it may become thin meat, as they keep away from the light source 3, and the detailed V groove which carries out outgoing radiation of the light which spreads the interior of a light guide plate 4-5 to outgoing radiation side 4a and 5a is formed.

[0029] The V groove to form is parallel to the shaft orientations of the light source 3, and although the brightness unevenness of the shape of stripes in outgoing radiation side 4b and 5b of a light guide plate decreases, so that an array pitch is fine, and visibility improves, it is the range of 200-500 micrometers from workability, and a flute width is 1 / 2 - 1/5 of an array pitch, and it is desirable to set up a flute width greatly as it keeps away from the light source 3, in order to equalize the outgoing radiation luminance distribution of a light guide plate.

[0030] The diffusion member 6 becomes transparent acrylic resin from the ingredient of the optical diffusibility which distributed the ingredient with which refractive indexes differ, for example, it is arranged above the light source 3 in the gap section of the light guide plate 4-5 of a pair, and both ends are laid in the edge of outgoing radiation side 4b and 5b of the light guide plate of a pair.

[0031] Moreover, the light source 3 of the diffusion member 6 and the field which counters are the W character molds which consist of two concave bend sides, each concave bend side is elliptical, there is one focus of an ellipse at the core O of the light source, and other foci P1 and P2 are on the horizontal-axis line which is in the minimum distance from the light source on plane-of-incidence 4a and 5a of a light guide plate 4-5.

[0032] Moreover, the ingredient which has reflective diffusibility in a concave bend side is formed in the dot pattern by printing etc. This dot pattern prevents high brightness-ization of the right above section from the light source 3, and reflects a part of light from the light source 3.

[0033] In addition, a dot pattern increases the reflected light by making it so dense that it being close to the light source 3, and can equalize the outgoing radiation light by the side of a panel 1.

[0034] Moreover, the brightness unevenness by the birefringence tends to generate the light source side edge section of light guide plate outgoing radiation side 4b and 5b in which the diffusion member 6 is laid, and equalization of brightness can be attained by forming a dot pattern in the contact surface of the diffusion member 6.

[0035] Reflecting plates 7 are metallic thin plates, such as aluminum, it is prepared in the rear-face side of the light guide plate 4-5 of a pair, and metal membranes, such as aluminum and silver, are vapor-deposited by the light guide plate 4-5 and the field of the side which counters.

[0036] The both ends of a reflecting plate 7 are stuck on field 4d.5d of the plane of incidence of the light guide plate of a pair, and the opposite side, are estranged and, as for the outgoing radiation side of a light guide plate, and field 4c and 5c of the opposite side, form the space layer.

[0037] Moreover, in the base of a reflecting plate 7, projection 7a of Yamagata parallel to the shaft orientations of the light source is prepared directly under the light source 3, and it inclines in the direction in which a space layer becomes narrow at the both-ends lower part of the light guide plate of a pair.

[0038] Next, actuation of the surface light source equipment of the above-mentioned configuration is explained. Although the light source 3 of cold cathode fluorescence tubing etc. emits light from a tubing internal surface to an omnidirection, the conceptual diagram on the basis of a light source core explains it. In drawing 4, incidence of the light of the include angle phi 1 which meets plane-of-incidence 4a and 5a of a light guide plate among the synchrotron orbital radiation from the light source is carried out to a light guide plate 4-5, the light of the above include angle phi 2 which does not meet a light guide plate progresses to the diffusion member 6, and the light of the down include angle

phi 3 progresses to a reflecting plate 7, respectively.

[0039] The light which carried out incidence to the light guide plate 4-5 progresses repeating total reflection within a light guide plate, and is refracted by the V groove of outgoing radiation side opposite side 4c and 5c, and outgoing radiation is carried out from outgoing radiation side 4band5b.

[0040] Although the light to the diffusion member 6 is divided into the light reflected by the reflective dot, and the light to penetrate and outgoing radiation of the transmitted light is carried out in the panel 1 direction, the reflected light is led to the downward reflecting plate 7 through the gap of the light source 3 and a light guide plate 4-5.

[0041] An optical path is both changed on the slant face of height 7a of the crest configuration of a reflecting plate 7, the light in which the light emitted to down from the light source 3 was reflected by the diffusion member 6 -- \*\* -- It progresses in the direction of both ends of a transparent material 4-5 through a space layer, and is reflected by slant-face 7b of the both ends of a reflecting plate 7, incidence is carried out from field 4cand5c of the outgoing radiation side of a light guide plate, and the opposite side, and outgoing radiation is carried out in the panel 1 direction.

[0042] As mentioned above, although the light emitted from the light source 3 produces the attenuation by several reflection, it is drawn in the panel 1 direction, without being absorbed by the light source 3.

[0043] Although an include angle phi 1 and phi 2 become large and the amount of incident light to a light guide plate increases so that it is narrow, as for spacing of the light guide plate 4-5 of a pair, it is desirable to set it as 1.5d-2d to the diameter d of the light source 3 because of the path of the light of include-angle phi3 direction reflected by the diffusion member 6.

[0044] Moreover, the amount of incident light increases so that the thickness of the plane of incidence of a light guide plate is large, but when a light guide plate uses acrylic resin, the incident angle of the light in which the refractive index carries out total reflection of the inside of a light guide plate, and spreads it by 1.49 is about 42 degrees, and it is desirable to set the include angle phi 1 based on the light sources as about 90 degrees.

[0045] An above-mentioned example is one example of this invention, and modification is possible in the range which does not deviate from a summary. For example, although the V groove formed in a light guide plate 4-5 was arranged at equal intervals and the flute width was enlarged in proportion to the distance from the light source 3, it is also possible for fixing a flute width and making spacing small in proportion to the distance from the light source 3 to be also able to equalize distribution of the outgoing radiation quantity of light from a light guide plate, and it to print a white coating to a dot pattern instead of a V groove.

[0046] Moreover, in order to cancel the bright line by the V groove engraved on the light guide plate in order to control and form into high brightness the angle of visibility of the light by which outgoing radiation is carried out in the direction of a panel from a light guide plate 4-5 and the diffusion member 6, \*\*\*\*\* which puts a prism sheet, a diffusion film sheet, etc. in between between a light guide plate and a panel does not interfere.

[0047] The space layer of the outgoing radiation side of a reflecting plate 7 and a light guide plate, and field 4c and 5c of the opposite side is a path which draws light in the direction of both ends of a transparent material 4-5, and ramp 7b of the both ends of a reflecting plate 7 can be omitted by making a reflecting plate 7 incline so that it may become narrow in the direction which keeps away from the light source.

[0048] Next, many above-mentioned light source units are arranged, and the example used as a back light of a liquid crystal panel is explained based on drawing 5 and drawing 6. In addition, it is the above-mentioned thing and above-mentioned approximation configuration about a light source unit, and explanation of the duplication section is omitted.

[0049] 1 is the display panel of the transparency mold with which the lattice of the liquid crystal display component was carried out into \*\*\*\*\* A, 2 is the box-like housing object which supports a display panel, and the light source unit [ two or more (drawing two pieces) ] is arranged inside the housing object 2.

[0050] The light guide plate 4-5 of the pair of a light source unit has spacing in the light source 3, is arranged, is energized in the direction which the spacing pushes by the energization member 8 with which the gap section of the both ends of the outside of a viewing area A was equipped, and spreads, and is stuck to it with the light guide plate of an adjoining light source unit. [ each other ]

[0051] A metal, resin, etc. consist of elastic material and the energization member 8 is being fixed to the housing object 2. The inferior surface of tongue of each light guide plate 4-5 is laid in the slant surface part of the housing object 2 through elastic support material, such as rubber which is not illustrated, and is close with the rear face of a display panel 1.

[0052] Although there is little number and it is activity top dominance to arrange in the direction of a short hand of a display panel 1, as for the array direction of a light source unit, it is desirable from the point of visibility to arrange horizontally by the busy condition of a liquid crystal display.

[0053] The bright line or the dark line of a connection can be hidden by setting the width of face (P) of the array

direction of a light source unit as the integral multiple of the liquid crystal pixel pitch of a display panel 8, and making a connection with an adjoining light source unit into the non-pixel location between pixels.

[0054] A reflecting plate 7 covers the rear face of all light guide plates in one, separates it from a light guide plate, and is being fixed to the housing object 2. As for the light guide plate of a reflecting plate 7, and the field which counters, projection 7a and 7c of Yamagata respectively parallel to the shaft orientations of the light source 3 are formed directly under [ of each light source 3 ], and directly under [ connecting location ] the light source unit.

[0055] About actuation of the light in the above-mentioned example, since it overlaps, it omits. In addition, since two or more light sources 3 are used, brightness can be made more into homogeneity to the brightness unevenness in the liquid crystal panel side 1 by aging and quantity of light dispersion of the light source 3 by preparing the adjustment device of an electrical potential difference or current control for every light source.

[0056] Moreover, of course, inserting a diffusion film sheet and a lens sheet between a light guide plate and a panel does not interfere for angle-of-visibility control of a liquid crystal display panel or the improvement in brightness.

[0057]

[Effect of the Invention] Since the display of a big screen can be lightweight-ized with a thin shape by arranging in parallel two or more light source modules which consist of a light guide plate of the pair of the light source according to this invention as explained above, adaptation in thin liquid crystal displays, such as a big-screen TV and a flat TV, is attained.

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[Translation done.]